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★**Nonparametric statistics on manifolds and their applications to object data analysis.**

With a foreword by Victor Pambuccian.

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In recent decades, starting with the statistical analysis of Kendall's similarity shapes, statistics of manifold-valued data has increasingly made an impact on the scientific community. While textbooks around the turn of the millennium focused on new statistical methodology based on parametric models for specific manifolds, the present book is the second to adopt the rather recent viewpoint of a nonparametric approach. In fact, the first author of the present book has pushed ahead with pioneering work allowing for general manifolds as data spaces, benefiting not only from statistics but also from a geometry background. After a while, beginning as his Ph.D. student, the second author joined the first author, and the present book is a condensation of almost two decades of intense research by these two and other researchers in the quest for nonparametrics on non-Euclidean spaces. Key topics in this context are two-sample tests based on manifold versions of the central limit theorem and bootstrap techniques to tackle the randomness of basepoints of the tangent spaces involved. Closely following varying applications in modern statistics, along with brief tutorials on multivariate statistics and on geometry and topology, the authors illustrate the above key topics for a multitude of data spaces and introduce additional topics such as density estimation on manifolds and persistent homology.

Beginners as well as advanced readers can profit from this book. The introductory part can very well be used as a crash course, with almost no prerequisites in probability and statistics, in order to arrive at Edgeworth expansions and two-sample problems in Hilbert spaces and Hilbert manifolds. Similarly, the introductory part to differential geometry and topology may serve well as a crash course, again with almost no prerequisites, arriving at Cartan-Hadamard spaces, touching harmonic analysis on homogeneous spaces and culminating in the Morse Lemma. Both introductions (i.e., Chapters 2 and 3) and their follow-up, an introduction to asymptotics and applications of Fréchet means in Chapter 4, come with sets of exercises. Often proofs, also of deeper results, are given in concise form, helping the student to acquire a better grasp of fundamental ideas and techniques of the field. Part I continues, in Chapters 5–7, with further theoretical aspects of nonparametric statistics on manifolds.

Part II, Chapters 8–14, presents asymptotic theory and nonparametric bootstrap on some special manifolds.

In addition to theoretical aspects, a large number of concrete data analysis examples are presented (e.g., brain imaging, structural biochemistry, uncalibrated stereo imaging and astronomy) on various data spaces ranging from similarity/affine/projective shape spaces over Stiefel and Grassmannian manifolds to the space of symmetric positive matrices. Part III, Chapters 15–25, is devoted to presenting a variety of applications of the methodology developed in the previous two parts.

Finally, some additional topics are presented in Part IV, Chapters 26 and 27.

Stephan Huckemann